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FEDERAL RESEARCH

Concerns About the Superconducting Super Collider

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss the Department of Energy's (DOE) Superconducting Super Collider (SSC). DOE has made considerable progress on the SSC project during the past year. The development of technical systems, such as the superconducting magnets, is advancing. In visiting the SSC site earlier this year, I noted that much conventional construction had been completed and was under way. To date, the Congress has provided about $1.3 billion toward the SSC's construction and is currently considering the President's request for another $650 million for fiscal year 1993. My testimony today points out a number of issues associated with the project that could delay the project, increase its cost to the U.S. government, or reduce potential benefits. Resolving these issues as soon as possible would protect the U.S. investment in the project.

My remarks are based primarily on our ongoing work on two assignments being conducted at the request of this Subcommittee. The first assignment focuses on the progress that DOE and the SSC Laboratory are making in developing the superconducting magnets and the detectors. The second assignment is examining the SSC project's cost and schedule changes.

My remarks today will focus on the following points:

-- Development of the superconducting magnets is progressing, but more work is needed before industry can mass-produce the magnets.

-- DOE does not have in place an integrated management system for monitoring the SSC project's cost and schedule performance; therefore, the potential impact of cost and schedule changes is not known.

-- The U.S. share of the project's cost could increase if DOE does not obtain the contributions that it is seeking from foreign sources.

-- After the SSC's construction has been completed in fiscal year 1999, the U.S. government will need to fund SSC operations at an estimated cost of $380 million a year (in fiscal year 1992 dollars); over the 25-year life of the project, these operational expenses will total an estimated $4.8 billion (in present-value terms).

-- The shorter-term benefits to the U.S. economy, such as the development of new spin-off technologies and the creation of jobs through the multiplier effect of SSC expenditures, will be diminished as a result of foreign participation in the building of the SSC.

Before I discuss these points in more detail, I would like to provide some background information on the SSC.

BACKGROUND

The SSC, which will be located about 30 miles south of Dallas, Texas, will be the world's largest high-energy particle accelerator. A particle accelerator is a research tool that physicists use to seek fundamental knowledge about energy and matter. The SSC will collide two beams of protons at an energy of 40 trillion electron volts (TeV). A principal feature of the SSC is two rings of superconducting magnets located in an underground tunnel 54 miles in circumference. The two rings of magnets will steer and focus the proton beams in opposite directions until they collide at various interaction regions where detectors will record the collisions for analysis by physicists. In January 1991, DOE estimated that the SSC would cost about $8.25 billion (in current-year dollars), about one-third of which DOE planned to obtain from nonfederal sources. Through fiscal year 1992, the federal government will have provided about $1.3 billion of the total estimate and the state of Texas will have furnished another $279 million. For fiscal year 1993, the President's budget request included another $650 million for the SSC.

The SSC project is structured so that Universities Research Association (URA),[1] the prime contractor, manages and operates the SSC Laboratory. URA awards subcontracts for conventional construction and production and for the design of project equipment. DOE is responsible for overseeing the project.

DEVELOPMENT OF MAGNETS IS PROGRESSING, BUT ADDITIONAL DESIGN WORK NEEDS TO BE DONE

Development of the superconducting magnets is progressing, but additional design work needs to be done before industry can mass-produce the magnets. As you know, the superconducting magnets, which are to operate at a very cold (near absolute zero) temperature, are the key to the successful operation of the SSC. The principal types are dipole magnets (bending magnets that have a north pole and a south pole) and quadrupole magnets (focusing magnets that have two north poles and two south poles). The completed SSC will contain about 8,600 dipole magnets and about 1,700 quadrupole magnets.

Last year, we reported that the magnet development schedule was compressed: development stages overlapped, and little or no

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[1]URA is a nonprofit consortium of 79 universities in the United States and Canada.

time was available between stages for resolving problems.[2] We expressed concern that such an approach increased the risks that the magnets would not work as intended. Although we still believe that the schedule is compressed, laboratory tests of full-size 50-millimeter dipole magnets have indicated that the laboratory-designed magnets will work. The SSC Laboratory will test the first group of industry-assembled demonstration magnets in an above-ground string test scheduled to be completed in the fourth quarter of fiscal year 1992. According to SSC Laboratory officials, the above-ground string test will determine whether the magnets will work together and with the other SSC components, including the electrical and cooling systems. The demonstration dipole magnets were assembled by industry at the laboratory but are laboratory-designed and built using laboratory tooling and assembly procedures. Industry is designing the magnets for the production phase using the laboratory-designed demonstration magnets as input to its design. Therefore, successful demonstration of the magnets in the string test will demonstrate progress but will not demonstrate that industry can produce the magnets at the rate needed to meet the production schedule (about 10 magnets per day).

The magnets will require further development before they can be produced industrially in the quantities needed for the SSC. For example, although quadrupole magnets developed by the Lawrence Berkeley Laboratory meet specifications and are expected to satisfy the requirements for a successful string test, the magnets' operating characteristics need to be improved for use in the SSC. To improve the design, the magnet contractor plans to build model magnets (1 meter in length) to test possible design improvements suggested by its subcontractor's experience in building magnets for the German accelerator, HERA. According to SSC Laboratory officials, this testing will not affect the SSC's cost or schedule because, instead of building as many prototype magnets (5 meters in length) as earlier planned, the magnet contractor will build model magnets. Nevertheless, the building of model magnets by industry helps illustrate that, whether the string test is successful or not, the magnets will need further development before they can be mass-produced.

INTEGRATED COST AND SCHEDULE SYSTEM IS NOT IN PLACE

Although DOE maintains that the SSC project is on schedule and within budget, it does not have in place an integrated system for monitoring cost and schedule performance that would allow it to objectively determine its progress. DOE acquisition regulations and the SSC project management plan require a Cost/Schedule Control System. Such a system is intended to (1) provide the SSC

[2] Federal Research: Status of DOE's Superconducting Super Collider (GAO/RCED-91-116, Apr. 15, 1991).

Laboratory with information essential for managing the SSC project and (2) form the data base for reporting progress on the project to DOE. However, after more than 3 years as the operating contractor for the SSC Laboratory, URA has yet to implement a functioning Cost/Schedule Control System. As a result, DOE lacks objective information to assess on a timely basis whether the project has encountered problems affecting its cost and schedule.

In the absence of a fully integrated cost and schedule system, the potential impact of all cost and schedule changes that have been made or are being considered is not known. URA has brought some cost changes to DOE's attention and received approval for them. As of early February 1992, the SSC Laboratory reported that it had used a net total of about $20 million of the $843 million that DOE had set aside for contingencies in the baseline cost estimate. However, other cost changes are being considered. We found three indications that the project's estimated cost might increase:

-- First, according to a trend analysis prepared by the conventional construction subcontractor, Parsons Brinckerhoff-Morrison Knudsen (PB/MK), the cost of conventional construction will exceed the $1.5-billion baseline cost estimate by $73 million to $383 million. URA has not reported this projection to DOE but is seeking to mitigate construction cost growth by, for example, reducing allocations for architectural and engineering services for future construction.

-- Second, the conventional construction subcontractor's analysis shows that the cost of constructing the experimental halls for the detectors may increase by $14 million. Additionally, completion of the halls, which are a critical path item and could affect the overall completion schedule for the project, may be delayed by 13 months. According to DOE, a 1-year slippage in the project's overall completion schedule would increase the project's costs by about $400 million, or roughly $1 million a day. The SSC Laboratory has not yet reported these potential cost increases to DOE but is considering actions to reduce cost and schedule slippages, such as concurrently designing and building the halls.

-- Lastly, DOE has deferred dealing with some cost increases in the expectation that the SSC Laboratory will find an alternative to using contingency funds. For example, DOE accelerated the schedule for developing string test magnets and approved the addition of five dipole magnets as back-ups for the seven dipole magnets already scheduled for the string test. To fund the additional magnet work, the SSC Laboratory submitted nine requests for a total of about $19 million in contingency funds. DOE approved two requests,

authorizing the use of about $5 million, but denied seven requests totaling about $14 million. Two of the denied requests, totaling about $3 million, had already been provided for in the budget and were erroneously requested. However, the other $11 million in denied costs have been incurred and still need to be recognized. According to an SSC Laboratory official, three requests totaling about $5 million will be offset by cost savings from other budgeted items or from the SSC Laboratory's management reserve, and the other three requests for funding the balance of about $6 million from contingency funds will be resubmitted to DOE.

DOE's Project Director advised us that he expects to have the integrated schedule tied to the baseline cost estimate by May 15, 1992.

SHORTFALLS IN FOREIGN CONTRIBUTIONS MAY INCREASE U.S. COST

Foreign contributions to the SSC have been slow to materialize. DOE estimates that the SSC project will cost about $8.25 billion but is seeking to obtain one-third of the project's funding from nonfederal sources. Additionally, only a little more than one-half of the estimated cost of two large detectors is included in DOE's baseline cost estimate, and DOE expects to obtain foreign contributions for the balance needed. If foreign contributions do not materialize to the extent that DOE is seeking, the U.S. government will have to increase its funding.

DOE has not yet received commitments for much of the funding that it is seeking from nonfederal sources. Texas has pledged $875 million toward the project's cost, leaving about $1.7 billion to be obtained from foreign countries. To date, India has pledged $50 million. Although DOE expects to receive contributions from other countries, such as Russia, DOE states that it needs a substantial contribution from Japan to meet the targeted amount. As you know, the United States and Japan have established a joint working group, which is examining possible Japanese contributions to the SSC. However, the nature and extent of Japan's contribution is not expected to be known until the end of this year.

DOE's estimated project cost of about $8.25 billion includes only enough funds for about one-half of the cost of the two large detectors. DOE has allocated a total of $550 million for the large detectors but has asked that each detector group--Solenoidal Detector Collaboration (SDC) and Gammas, Electrons, Muons (GEM)--design its detector to cost $500 million, for a total cost of $1 billion. Although each detector group is seeking to design a $500-million detector, SDC estimated the cost of its detector at $584 million in its April 1992 technical proposal. The respective detector groups are to seek and obtain contributions from foreign

collaborators--apart from the $1.7 billion in contributions sought for the accelerator itself--to make up for the funding shortfall. To date, no firm foreign commitments for contributions to the detectors have been received. If foreign contributions do not materialize, the U.S. cost of the two large detectors could increase by as much as $500 million or more. However, DOE and SSC Laboratory officials advised us that, rather than request additional funds from the Congress, they would either reduce the size of the two large detectors or build only one large detector.

SSC OPERATING COSTS REPRESENT AN ADDITIONAL FUNDING COMMITMENT

Once the SSC has been constructed, the federal government will need to fund its operations. The costs of operating the SSC represent a long-term funding commitment in addition to the estimated construction costs. DOE projects that annual funding requirements for the SSC after its construction has been completed in fiscal year 1999 will be $380 million (in fiscal year 1992 dollars). This projection includes annual estimates of about $224 million to operate the accelerator, $55 million for accelerator improvement projects, $35 million for general plant projects, and $66 million for capital equipment. Projected over the SSC's estimated 25-year life, the present value of these costs will total about $4.8 billion (see attach. I).

FOREIGN INVOLVEMENT REDUCES SHORTER-TERM BENEFITS TO THE UNITED STATES

The completed SSC should give scientists a tool for exploring the fundamental nature of matter and energy. Fundamental knowledge acquired could provide the basis for long-term benefits to humanity. In the shorter term, spin-off benefits can be anticipated from the use of state-of-the-art technologies, such as superconductors, in constructing the accelerator, and the creation of jobs through the multiplier effect of SSC expenditures.[3] According to DOE's Acting Deputy Secretary, the SSC has already created about 7,000 jobs. However, because some work is to be performed overseas, all short-term economic benefits will not remain in the United States.

Foreign subcontractors will build some components, such as collared coils for the 1,700 quadrupole magnets, overseas. A

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[3]In an April 7, 1987, hearing before the Subcommittee on Energy Research and Development, Senate Committee on Energy and Natural Resources, DOE's Director, Office of Energy Research, called attention to a 1984 study by the European Organization for Nuclear Research (CERN), Economic Utility Resulting From CERN Contracts (Second Study), which found that every Swiss franc spent by CERN generated three Swiss francs of economic utility.

German firm, Siemens, has a $16.6-million subcontract with Babcock and Wilcox, the U.S. contractor for the quadrupole magnets, for developing and building collared coils for the first 147 quadrupole magnets. The collared coils represent about one-third of the magnets' cost. Out of an estimated $166 million for 1,700 quadrupole magnets, the collared coils will cost a total of about $50 million, according to an SSC Laboratory official. Building the coils in Germany increases the possibility that spin-off technologies will go to foreign firms and reduces the multiplier effect of the SSC investment on the U.S. economy.

Superconducting cable is a critical element in all the superconducting magnets and will cost about $400 million. The SSC Laboratory has a vendor qualification program to develop industry's capability to provide the wire and cable needed for the superconducting magnets. Plans call for separate suppliers for the inner and outer cables for the collider magnets, and for the cable for the High Energy Booster magnets. As the tables in attachment II show, the SSC Laboratory has subcontracts with seven suppliers that are participating in the vendor qualification program. Three of the companies have wire and/or cable manufacturing plants located in the United States, and the other four, all of which are foreign companies, do not. The subcontracts are for about 2 years and range from about $2 million to $3 million each. Additionally, another foreign firm is participating in the qualification program on its own to become a qualified supplier. The SSC Laboratory's program for qualifying cable suppliers is intended to help ensure that potential suppliers are qualified to produce the needed cable and that competition exists for the cable subcontracts. However, the extensive participation by foreign firms in this program will result in the SSC Laboratory's developing capability for these foreign firms to compete for the cable subcontract(s) with U.S. companies. Any such subcontracts with foreign suppliers will further reduce the multiplier effect of the investment on the U.S. economy.

To take advantage of the cheaper cost of building the conventional magnets overseas, DOE plans to have the conventional magnets for the Low Energy Booster and Medium Energy Booster rings built abroad. In late January 1992, Russia's Institute for Nuclear Physics at Novosibirsk signed an agreement with the SSC Laboratory to supply conventional magnets and related equipment valued at about $125 million. The SSC Laboratory expects that it will compensate the Russian Institute by an amount equal to about one-half of the $125 million.

CONCLUSION

As previously stated, the aforementioned issues have the potential to delay the project, increase its cost to the United States, or reduce potential benefits. With another year's funding, the federal investment in the SSC project will increase by about 50

percent, from about $1.3 billion to over $1.9 billion. We believe that as the investment increases and construction advances, there is an increased likelihood that the project will continue to be funded even if costs increase and other countries do not help pay for it. Accordingly, correcting the problems we have noted and obtaining firm funding commitments from other nations as soon as possible are necessary to protect the U.S. investment in the project. Continuation of federal funding could also be made contingent on DOE's putting in place an integrated cost and schedule system, assessing the impact on the domestic economy of using foreign subcontractors (and of any anticipated in-kind foreign contributions), and obtaining firm commitments for contributions from other nations by a certain date.

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Mr. Chairman, this concludes my prepared statement. We will be happy to respond to any questions you may have.

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